Space Weather Technical Forecast

Issued on Sunday, 29 October 2023 at 01:22 Local

This technical forecast provides a four day assessment of space weather events. The probabilities stated below are for reaching or exceeding the given levels. For more information about space weather impacts please see the Met Office Space Weather Scales https://www.metoffice.gov.uk/weather/learn-about/space-weather/uk-scales

Space Weather Forecast Headline: G1 Minor Storms expected day 1 (29 Oct) with a chance G2 Moderate Storm intervals. Risk decreasing day 2 (30 Oct) onward. Active fluence likely day 3-4 (31 Oct-01 Nov).

Analysis of Space Weather Activity over past 24 hours

Solar Activity: Low with only isolated low level C-class flares, peaking C1.6 at 28/0623 from AR3473 in the northeast disc. There are four sunspot regions on the disc, all of which are small with little sign of notable growth. AR3473 is the largest, with the only penumbral region on the disc. AR3474 in the southeast is also of note due to a slightly more complex beta-gamma structure. No Earth-directed CMEs have been observed, with the main visible CME off the southeast disc assessed as being from the far-side.

Solar Wind / Geomagnetic Activity: A gradual transition into the fast wind of CH66/+ has likely been observed. Solar wind speeds were initially background, at 350 km/s, but erratically climbed through the period to reach around 570 km/s by 29/0000 UTC. Density fell from around average to below average. The total Interplanetary Magnetic Field (IMF), Bt, has ranged from Weak to Moderate levels, between 5 and 12 nT. The north-south component, Bz, was mostly negative (southward), ranging -10 nT to +8nT. Phi angle has remained predominantly positive (away from the Sun). Geomagnetic activity was initially Quiet (Kp 1), but became Unsettled to Active (Kp3-4) from 28/0300 UTC.

Energetic Particles / Solar Radiation: GOES16 high energy (greater than 10MeV) proton flux was at background levels. GOES16 high energy (greater than 2MeV) electron flux was at background. The associated 24-hour fluence remains well below the Active (1e8 integrated pfu) threshold. The observation at 29/0000UTC was 2.68e6 integrated pfu.

Four-Day Space Weather Forecast Summary

Solar Activity: Very Low or Low activity is expected, with isolated C-Class flares. There is a slight chance of isolated M-flares.

Solar Wind / Geomagnetic Activity: There are no Earth directed CMEs. Current solar wind enhancement is due to an ongoing transition into the fast wind of CH66/+. This is expected to dominate through the period. Solar winds are expected to peak day 1 (29 Oct) at around 600-700km/s, before easing gradually through the rest of period. Unsettled to G1 Minor Storm activity is expected day 1 with a chance of an isolated G2/Moderate storm interval. Activity then easing, to Quiet to Active day 2 (30 Oct), then Quiet to Unsettled with a chance of Active intervals day 3 (31 Oct). Given the expected wind speeds there also remains a chance of isolated G1 Minor Storm intervals day 2, and a slight chance day 3.

Energetic Particles / Solar Radiation: High energy (greater than 10MeV) proton flux is expected to persist at Background. High energy electron flux (greater than 2MeV) is forecast to be at background at first, but increasing later in the period to Moderate, potentially High levels, as any solar wind pressure from the current ongoing fast wind enhancement eases. This most likely from late day 2 (30 Oct). The associated 24 electron fluence is expected to see a rising trend, with a chance of reaching Active (1e8 integrated pfu) day 3 onward (31 Oct).

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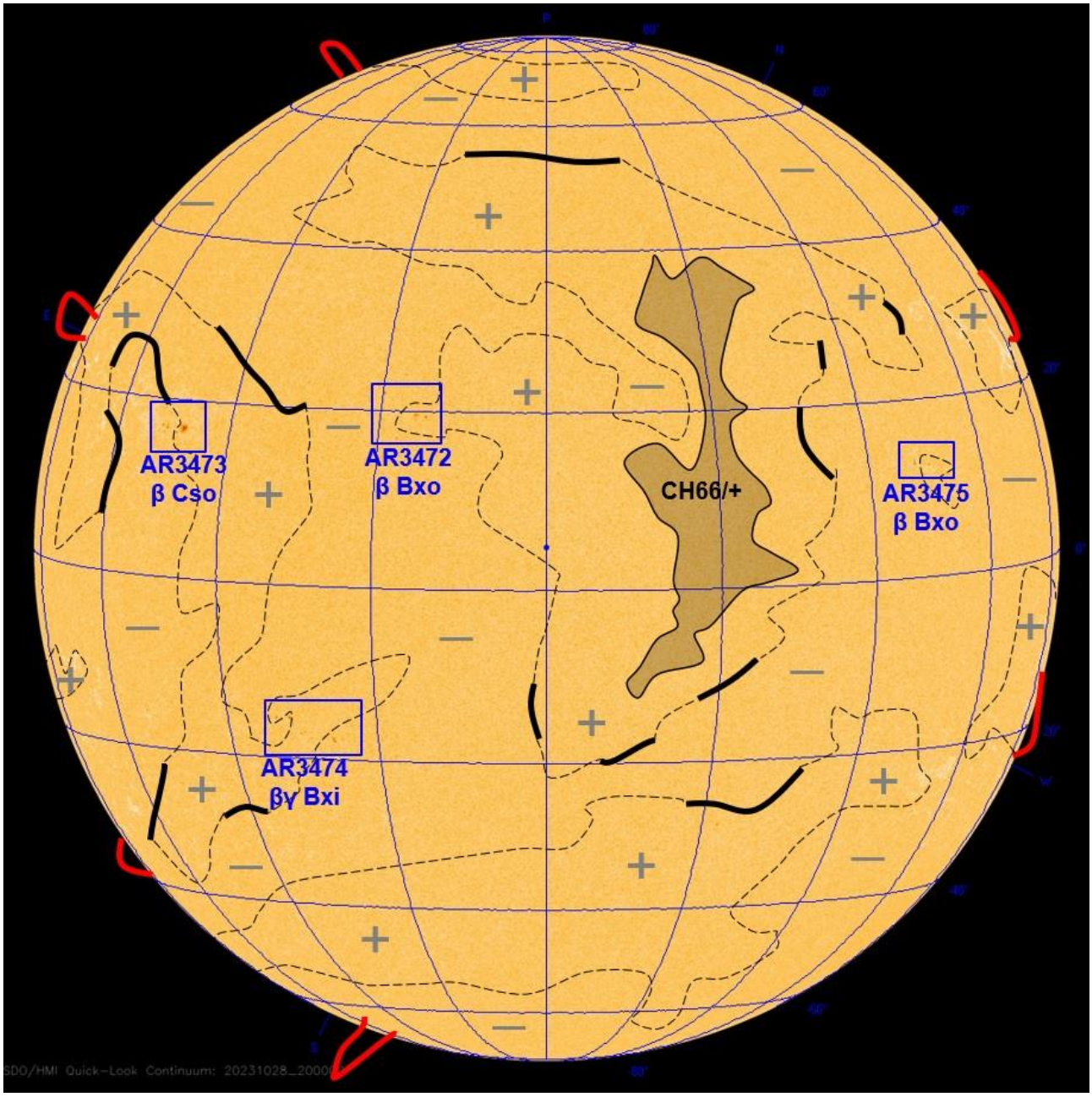
Figure 1. Solar Analysis Valid 29/2000 UTC.



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Key: Filament ___ , Prominence ___ , Magnetic Field Line - - - , Polarity +/-, Coronal Holes: Grey shaded area CHxx +/-, Sunspot groups 25xx - Mt Wilson α-β-βγ-βγδ and Zurich-McIntosh Axx etc.

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Geomagnetic Storms:

There are no Earth-directed CMEs. Large CH66/+ is the main feature of interest, and despite its location being just west of centre disc has been assessed as already being the main influence on current winds

Solar wind speeds are expected to continue increasing as Earth moves fully into the fast wind from it, with the potential for peaking 600-700 km/s day 1 (29 Oct), before only gradually easing day 2 onward (30 Oct). These winds likely remaining slightly elevated until later day 4 (31 Oct-01 Nov).

MOSWOC enlil has a good representation of the fast wind from day 1 (29 Oct), however the model connected to CH66 too early prior to this. Winds speeds are likely to peak a little higher than Enlil suggests, before gradually easing as indicated. CH66/- barely featured on the previous rotation, leading to lower confidence for more significant geomagnetic activity. This is despite the coronal holes size, and it being well defined in imagery, as it is more persistent high speed streams and the transition through their CIRs that tend to reach the higher geomagnetic levels.

Unsettled to G1 Minor Storm activity is expected day 1 with a chance of an isolated G2/Moderate storm interval. Activity then easing, to Quiet to Active day 2 (30 Oct), then Quiet to Unsettled with a chance of Active intervals day 3 (31 Oct). Given the expected wind speeds there also remains a chance of isolated G1 Minor Storm intervals day 2, and a slight chance day 3.

Geo-Magnetic Storm Probability (Exceedance)	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Minor or Moderate	G1 to G2	No	80	40	20	1
Strong	G3	No	5	1	1	1
Severe	G4	No	1	1	1	1
Extreme	G5	No	1	1	1	1

Figure 2a: SDO aia-211 of previous rotation (left) and current (right) Very different CH structure.

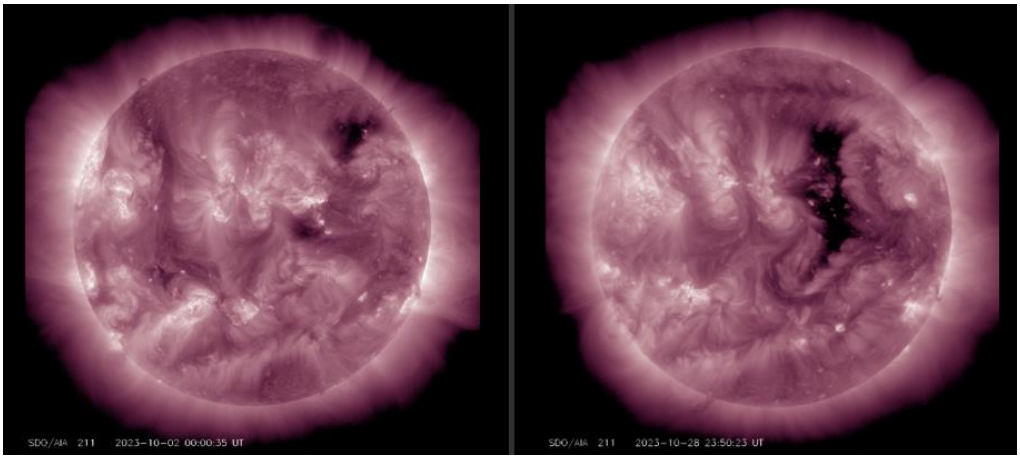

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Figure 2b: Enlil showing prolonged CH enhancement.

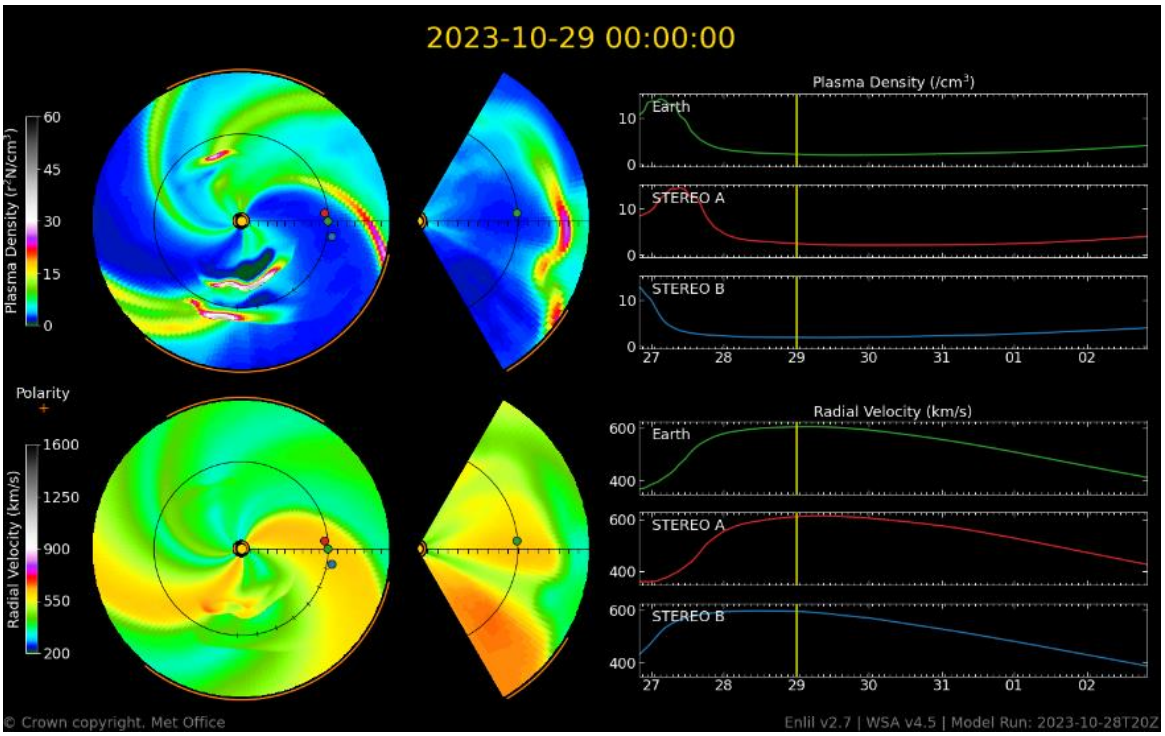
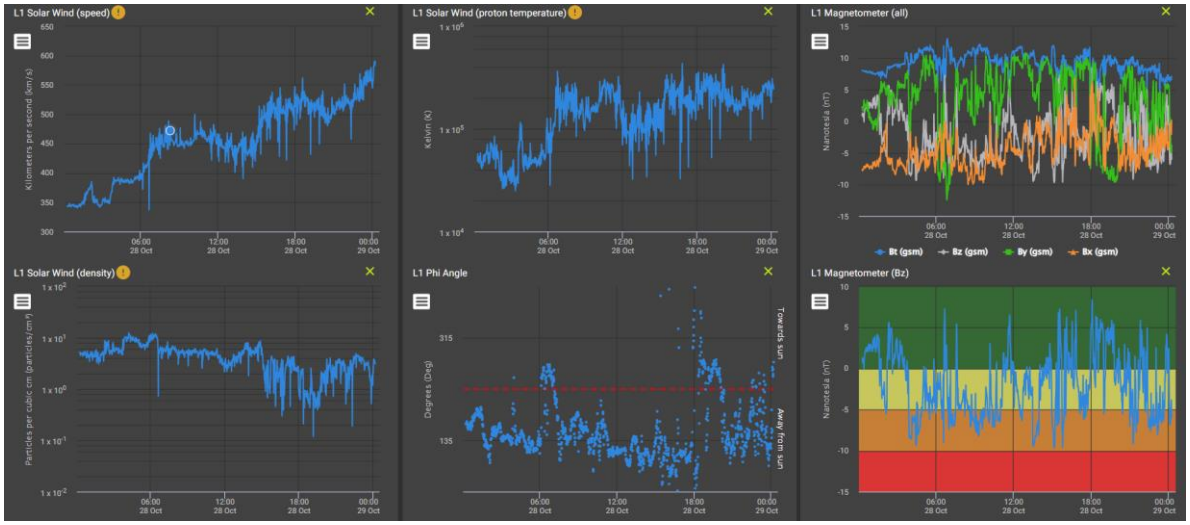


Figure 2c: Observed solar winds at ACE, showing erratic rise on 28 Oct.



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Radio Blackouts - X-Ray Flares:

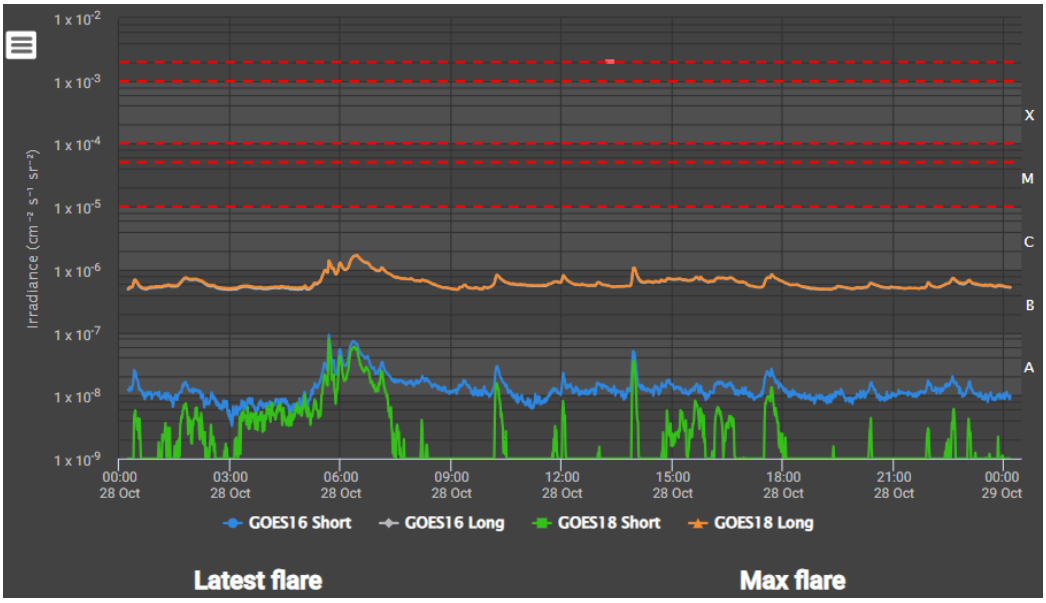
Low activity, perhaps Very Low at times, is expected to continue, with only four small and weak sunspots currently on the Earth-facing disc. There is a slight chance of M-class flares, however these will likely be from either further development, filament lifts or features that are currently not on the visible disc (e.g. around the east limb).

The most notable of the visible sunspots is AR3474 in the southeast, which has a slightly more complex beta-gamma structure, however this remains very small, with little sign of any notable growth. AR3473 in the northeast is also of note, containing the only penumbra on the visible disc, and also being the source of the largest observed flare in the last 24 hours.

While the Earth-sided disc is currently clear of spots, imagery from Mars Perseverance rover does reveal a couple of far-sided spots, with Mars currently opposite Earth in its orbit. These are likely to start moving onto the visible disc later in the coming week (from 01 Nov), perhaps bringing an end to the current lull in activity.

X Ray Flares Probability	Level	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	R1-R2 M Class	No	10	10	15	25
Very Active	R3 to R5 X Class	No	1	1	1	1

Figure 3: GOES-16/18 X-ray Flux



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Solar Radiation Storms - (High Energy Protons):

The high energy (greater than 10MeV) proton flux observed by GOES16 is expected to persist at background levels in the absence of significant sunspot regions on the visible disc.

Radiation Storms Probability (Exceedance)	Level (cm^{-2} sr^{-1} s^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ S1	No	1	1	1	1
Very Active	≥ S3 *	No	1	1	1	1
* S3 ≥ 10 MeV ≥ 1000 pfu and / or ≥ 50 MeV ≥ 10 pfu. (pfu = $cm^{-2}sr^{-1}s^{-1}$)						

High Energy Electrons Event (≥ 2MeV):

High energy electron flux (greater than 2 MeV) observed by GOES16 at GEO is currently at background, although recent solar wind enhancements have likely increased populations at lower orbits. Ongoing solar wind pressure through day 1 (29 Oct) will likely limit the potential for flux to rise at GEO at first, but with an increasing chance of reaching High through days 2-4 (30 Oct-01 Nov) as solar winds and any ongoing geomagnetic activity eases. There is the potential for persistently high flux by the end of the period

The associated 24 hour fluence is expected to see an increasing trend, likely reaching active days 3-4 (31 Oct-01 Nov), with a chance of reaching this level earlier on day 2 (30 Oct). REFM has yet to take account of the current solar wind enhancement, so while likely giving good guidance in the short term this will give a poor indication beyond T+24.

GEO Electron Environment Probability (Exceedance)	Level (cm^{-2} sr^{-1} day^{-1})	Past 24 Hours (Yes/No)	Day 1 (00-24 UTC) (%)	Day 2 (00-24 UTC) (%)	Day 3 (00-24 UTC) (%)	Day 4 (00-24 UTC) (%)
Active	≥ 2 MeV ≥ $1x10^8$	No	5	30	60	70
Very Active	≥ 2 MeV ≥ $1x10^9$	No	1	1	1	1

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